

# PATENT ABSTRACTS OF JAPAN

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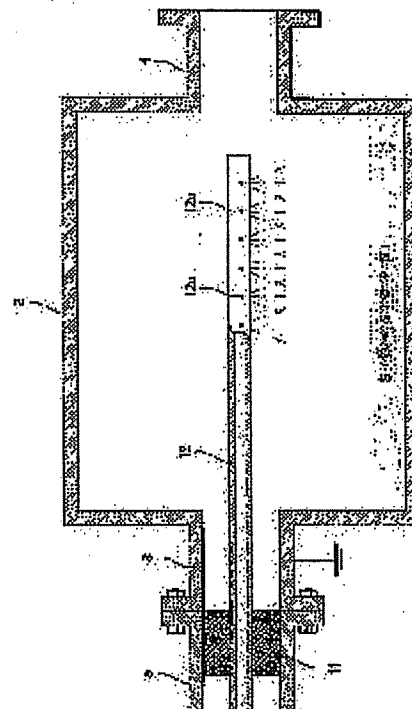
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## (54) METHOD AND DEVICE FOR WATER DECOMPOSITION

### (57)Abstract:

PROBLEM TO BE SOLVED: To decompose water more continuously at lower degrees than by prior art.

SOLUTION: A cylindrical metallic reactor 2 has an inlet 3; to which a tube 5 is connected, and an outlet 4. A metallic pipe 12 for supplying water is held in the tube 5 via an insulator 11 such as Teflon(R), and the part of the pipe facing onto the reactor 2 has equally spaced holes 13 for flushing water. The reactor 2 is grounded and the pipe 12 is insulated from the reactor so that both can react as electrode potential forming electric fields. The reactor 2 works as cathode and the metallic pipe 12 works as anode.



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**CLAIMS**

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[Claim(s)]

[Claim 1]A catalyst which made oxidized silicon or titanium oxide with a subject an activity steam heated by not less than 300 \*\* 600 \*\* or less is contacted, A decomposing method of water making oxidized silicon or titanium oxide which made  $H^+$ , oxidized silicon, or titanium oxide in an activity steam react, and separated an oxygen atom from said oxidized silicon or titanium oxide, and an oxygen atom separated, and an activity steam react, and separating a hydrogen atom.

[Claim 2]A decomposing method of water performing said reaction in a decomposing method of the water according to claim 1 in atmosphere in which an electric field was formed.

[Claim 3]A decomposing method of water, wherein electrode potential (standard oxidation reduction potential) of a catalyst which made said oxidized silicon a subject in a decomposing method of the water according to claim 1 is 0mV—700mV.

[Claim 4]A decomposing method of water, wherein electrode potential (standard oxidation reduction potential) of a catalyst which made said titanium oxide a subject in a decomposing method of the water according to claim 1 is +50mV—50mV.

[Claim 5]A decomposing method of water, wherein a catalyst which made said oxidized silicon a subject is manufactured considering zeolite as a starting material in a decomposing method of the water according to claim 1 and a catalyst which made said titanium oxide a subject is manufactured considering a rutile ore as a starting material.

[Claim 6]A cracking unit of water characterized by comprising the following.

A reaction vessel connected with a pressure reducing device while storing a catalyst which made oxidized silicon or titanium oxide a subject.

A heating method which heats this reaction vessel.

A water supplying means which supplies water in said reaction vessel.

[Claim 7]A cracking unit of water, wherein said reaction vessel rotates in a cracking unit of the water according to claim 6.

[Claim 8]A cracking unit of water, wherein said water supplying means serves as an electrode of another side which serves as an electrode and in which while said reaction vessel forms an electric field forms an electric field in a cracking unit of the water according to claim 7.

[Claim 9]A cracking unit of water, wherein a water jet hole is formed in a portion which said water supplying means consists of metallic pipes, and faces in a reaction vessel of this metallic pipe in a cracking unit of the water according to claim 8.

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the decomposing method of water, and its device.

[0002]

[Description of the Prior Art]Hydrogen and oxygen which are obtained by decomposing water are not only used for the chemical industry, semiconductor device manufacture, metal metallurgy, food stuff industry, etc., but demand will be increasingly expected as a clean energy source from now on.

[0003]In order to use industrially by making hydrogen or oxygen into an energy source, it becomes indispensable that it can manufacture continuously. How to obtain by \*\* electrolysis of water as a conventional method of manufacturing hydrogen or oxygen continuously, \*\* The steam reforming process acquired by making methane and the steam heated by 700 \*\* – 800 \*\* react and the method of decomposing water into hydrogen and oxygen under catalyst existence, such as iron oxide, under the elevated temperature beyond \*\*1000 \*\* are known from the former.

[0004]

[Problem(s) to be Solved by the Invention]As for an electrolytic process, it is impossible in cost that an electricity bill industrializes in a high country like our country among the manufacturing methods mentioned above. The steam reforming process which can choose the heat source of a more efficient fuel oil than electrical energy etc. has the fault of also large-scale-izing equipment, with discharge of the carbon dioxide constituting that reaction temperature is high as mentioned above and the cause of global warming. The method of making the catalyst of iron oxide etc. contacting under a not less than 1000 \*\* elevated temperature also has the same problem as a steam reforming process.

[0005]

[Means for Solving the Problem]A decomposing method of water poured on this invention that an aforementioned problem should be solved, A catalyst which made oxidized silicon or titanium oxide with a subject an activity steam heated by not less than 300 \*\* 600 \*\* or less is contacted, Make oxidized silicon or titanium oxide, and  $H^+$  in an activity steam react, oxidized silicon or titanium oxide which separated an oxygen atom from said oxidized silicon or titanium oxide, and an oxygen atom separated, and an activity steam are made to react, and it was made to separate a hydrogen atom.

[0006]As for said reaction, it is preferred to carry out in atmosphere in which an electric field was formed. As for electrode potential (standard oxidation reduction potential) of a catalyst which made said oxidized silicon a subject, being referred to as +50mV—50mV is [ electrode potential (standard oxidation reduction potential) of a catalyst which made 0mV—700mV and titanium oxide a subject ] preferred.

[0007]Here, it is considering it as a granular material as said catalyst, since a touch area with a steam becomes large, it is preferred to consider it as a granular material, but a catalyst body fabricated in shape like a honeycomb structured body may be used. And when a catalyst is made

into powder state, a decomposition reaction arises efficiently at reacting rotating a reaction vessel, but in particular when a catalyst is made into shape like a honeycomb structured body, it is not necessary to rotate a reaction vessel.

[0008]A cracking unit of water of this invention is characterized by comprising:

A reaction vessel connected with a pressure reducing device while storing a catalyst which made oxidized silicon or titanium oxide a subject.

A heating method which heats this reaction vessel.

A water supplying means which supplies water in said reaction vessel.

Said reaction vessel can be considered, for example as a pivotable structure.

[0009]It is preferred to have composition which can form an electric field in a reaction vessel, and said water supplying means can serve as an electrode of another side which serves as an electrode and in which while a reaction vessel forms an electric field in this case forms an electric field.

[0010]In this case, a water supplying means can be used as a metallic pipe, and a water jet hole can be formed in a portion which faces in a reaction vessel of this metallic pipe.

[0011]In the case of oxidized silicon, it is presumed as the following that a main reaction in a reaction vessel is. If a steam will be not less than 300 \*\*, activity will increase and the part will become a hydrogen ion and a hydroxide ion.

Activation  $\text{H}_2\text{O} \rightarrow \text{H}^+ + \text{OH}^-$  of a steam .....(1)

A reduction reaction of a catalyst (generating of oxygen gas)

$\text{SiO}_2 + \text{OH}^- \rightarrow \text{SiO} + \text{O}_2 + \text{H}^+ + 2\text{e}^-$  .... (2)

Generating  $\text{H}^+ + \text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$  of hydrogen gas .....(3)

Oxidation reaction  $\text{SiO} + \text{H}_2\text{O} \rightarrow \text{SiO}_2 + \text{H}_2$  of a catalyst .....(4)

[0012]A main reaction in a reaction vessel can also be presumed as follows.

Activation  $\text{H}_2\text{O} \rightarrow \text{H}^+ + \text{OH}^-$  of a steam .....(5)

Reduction reaction of a catalyst  $\text{SiO}_2 + \text{H}^+ \rightarrow \text{SiO}^{2+} + \text{OH}^-$  ..... (6)

$\text{SiO}^{2+} + 2\text{e}^- \rightarrow \text{SiO}$  .....(7)

Generating of oxygen gas  $\text{OH}^- + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{O}^{2-}$  .....(8)

$\text{O}^{2-} \rightarrow 1/2\text{O}_2 + 2\text{e}^-$  .....(9)

Oxidation reaction of a catalyst (generating of hydrogen gas)

$\text{SiO} + \text{H}_2\text{O} \rightarrow \text{SiO}_2 + \text{H}_2$  .....(10)

[0013]while attracting hydrogen ( $\text{H}_2$ ) and oxygen ( $\text{O}_2$ ) from the inside of a reaction vessel and decompressing inside of a reaction vessel, by supplying  $\text{H}_2\text{O}$ , the above-mentioned reaction formula is seen rightward, it can continue and the reaction can generate hydrogen ( $\text{H}_2$ ) and oxygen ( $\text{O}_2$ ) continuously. Since hydrogen ( $\text{H}_2$ ) and oxygen ( $\text{O}_2$ ) which were generated are mixed, except for a case where a recombination reaction is used, a publicly known means separates hydrogen ( $\text{H}_2$ ) and oxygen ( $\text{O}_2$ ).

[0014]Here, although a hot steam is activity very much, for temperature being not less than 600 \*\*, it will not be desirable in respect of energy efficiency, and a recombination reaction of hydrogen ( $\text{H}_2$ ) and oxygen ( $\text{O}_2$ ) will occur at this temperature. Then, a steam is easily activable by forming an electric field in a reaction chamber also at a to some extent low temperature (300 \*\* - 600 \*\*).

[0015]Generating hydrogen, if SiO contacts water is known from the former. Thus, if SiO oxidizes and it becomes  $\text{SiO}_2$ , a reaction will not usually progress any more. However, if it is in this invention, it is contacting an activity steam for a catalyst (mixture containing  $\text{SiO}_2$ , SiO, and Si) which made oxidized silicon a subject, and a cycle of  $\text{SiO}_2 \rightarrow \text{SiO} \rightarrow \text{SiO}_2 \rightarrow \text{SiO}$  is repeated.

[0016] In the case of titanium oxide, it is presumed as the following that a main reaction in a reaction vessel is.

Activation  $\text{H}_2\text{O} \rightarrow \text{H}^+ + \text{OH}^-$  of a steam .....(11)

A reduction reaction of a catalyst (generating of oxygen gas)

$\text{TiO}_2 + \text{OH}^- \rightarrow \text{TiO} + \text{O}_2 + \text{H}^+ + 2\text{e}^-$  .... (12)

Generating  $\text{H}^+ + \text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$  of hydrogen gas .....(13)

Oxidation reaction  $\text{TiO} + \text{H}_2\text{O} \rightarrow \text{TiO}_2 + \text{H}_2$  of a catalyst .....(14)

[0017] A main reaction in a reaction vessel can also be presumed as follows.

Activation  $\text{H}_2\text{O} \rightarrow \text{H}^+ + \text{OH}^-$  of a steam .....(15)

Reduction reaction of a catalyst  $\text{TiO}_2 + \text{H}^+ \rightarrow \text{TiO}_2 + \text{H}^+ + \text{OH}^-$  ..... (16)

$\text{TiO}_2 + 2\text{e}^- \rightarrow \text{TiO}$  .....(17)

Generating  $\text{OH}^- + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{O}^{2-}$  of oxygen gas .....(18)

$\text{O}^{2-} \rightarrow 1/2\text{O}_2 + 2\text{e}^-$  .....(19)

Oxidation reaction of a catalyst (generating of hydrogen gas)

$\text{TiO} + \text{H}_2\text{O} \rightarrow \text{TiO}_2 + \text{H}_2$  .....(20)

[0018]

[Embodiment of the Invention] An embodiment of the invention is described below, referring to an accompanying drawing. The figure and drawing 2 in which an example of the entire configuration of the cracking unit of the water which requires drawing 1 for this invention is shown here are a sectional view of the important section of an isomerism solution device.

[0019] In the insulation case 1 whose opening and closing were enabled, the cracking unit of water arranges the tubed metal reaction vessels 2. It has the inlet section 3 and the exit part 4, the shell 5 is connected to the inlet section 3, the shell 6 provided with the valve 6a is connected to the exit part 4, and the reaction vessel 2 is supporting these shells 5 and 6 movably in bearing 7 —, enabling free rotation, as shown also in drawing 2.

[0020] The motor M is formed in a floor line, and he stretches the chain 10 between the drive sprocket 8 of this motor M, and the passive-movement sprocket 9 provided in said shell 5, and is trying to rotate the reaction vessel 2 by driving the motor M. In the insulation case 1, the heater H which heats the reaction vessel 2 is formed, and the thermometer T which measures the temperature of the reaction vessel 2 is inserted into the insulation case 1.

[0021] On the other hand, in said shell 5, the metallic pipe 12 for water supplies is held via the insulators 11, such as Teflon and ceramics, and while the tip which faces in the reaction vessel 2 of this metallic pipe 12 is blockaded, the water jet hole 12a is formed with the prescribed interval. And the tube 14 from the tank 13 which filled pure water is connected to the other end of the metallic pipe 12. The tap 15 is formed in the middle of the metallic pipe 12.

[0022] Here, since said reaction vessel 2 is grounded and the metallic pipe 12 is insulated in this reaction vessel 2, both act as an electrode which forms an electric field. Incidentally, the reaction vessel 2 acts as a cathode and the metallic pipe 12 acts as an anode.

[0023] It is connected to piping extended from the buffer tank 17 via the joint 16, and said shell 6 is attracted by vacuum pump P in this buffer tank 17 below at predetermined pressure. The gas in this buffer tank 17 is attracted by the tank 18 for cooling, the gas in the tank 18 is introduced in the tank 19, and O<sub>2</sub> densimeter is attached to this tank 19. It may be made to return the water of condensation which collected in the buffer tank 17 in the middle of the metallic pipe 12 via the piping 20.

[0024] Next, the concrete example of an experiment using an above device is described below. (Example 1 of an experiment) 200g of catalysts (standard oxidation reduction potential: -700mV) which made the subject the oxidized silicon which created zeolite as a starting material are supplied in a 10-l. reaction vessel. After decompressing to 0.1 atmosphere or less, it heated gradually with the following heating rates by 10 \*\*/until the temperature in a reaction vessel

became 350 \*\*, 50 \*\* a heating rate from 50 \*\* to 100 \*\* for 30 minutes 15 minutes, 150 to 200 \*\* heated [ from 100 \*\* / for 30 minutes / \*\* / 350 ] 300 \*\* for 150 \*\* from 300 \*\* from 250 \*\* over 15 minutes for 15 minutes for 30 minutes for 30 minutes to 250 \*\* from 200 \*\*.

Subsequently, 200-cc pure water (ion exchange water) was gradually supplied in the reaction vessel, heating so that the temperature in a reaction vessel may not be 350 \*\* or less. Supply of pure water would raise the oxygen concentration in a reaction vessel rapidly to 22vol% (1atm conversion). Then, vacuum suction was suspended, the valve was made close and heating was continued. As a result, when the pressure and temperature in a reaction vessel rose gradually and passed for 20 minutes, it became about 1.5 atmospheres and about 600 \*\*, and the recombination reaction of the emitted oxygen gas and hydrogen gas occurred, and the inside of a reaction vessel fell at a stretch to 0.8 atmosphere. Then, while making the valve open and decompressing to 0.1 atmosphere, pure water was supplied again, vacuum suction was suspended, the valve was made close, and heating was continued. Then, the recombination reaction occurred again.

[0025](Example 2 of an experiment) It experimented on the same conditions as said example 1 of an experiment except having heated so that the temperature in a reaction vessel might not be 300 \*\* or less. As a result, the generating efficiency of the oxygen gas at the time of supplying pure water fell to 10vol%. Then, like the example 1 of an experiment, while suspending vacuum suction, the valve was made close and heating was continued. As a result, when the pressure and temperature in a reaction vessel rose gradually and passed for 45 minutes, it became about 1.5 atmospheres and about 600 \*\*, and the recombination reaction of the emitted oxygen gas and hydrogen gas occurred, and the inside of a reaction vessel fell at a stretch to 0.8 atmosphere.

[0026](Example 3 of an experiment) It experimented on the same conditions as said example 1 of an experiment except having heated so that the temperature in a reaction vessel might not exceed 250 \*\*. As a result, most generating of the oxygen gas at the time of supplying pure water was not accepted. The rise of the pressure was not seen, even if the valve was made close and it continued the state below 250 \*\*.

[0027](Example 4 of an experiment) Except that standard oxidation reduction potential used a 0 mV (there are many rates of  $\text{SiO}_2$ ) catalyst, it experimented on the same conditions as said example 1 of an experiment. As a result, the generating efficiency of the oxygen gas at the time of supplying pure water reached to 18vol%. Then, vacuum suction was suspended, the valve was made close and heating was continued. As a result, when the pressure and temperature in a reaction vessel rose gradually and passed for 20 minutes, it became about 1.5 atmospheres and about 600 \*\*, but the recombination reaction did not occur.

[0028](Example 5 of an experiment) It experimented on the same conditions as said example 1 of an experiment except having used the catalyst (standard oxidation reduction potential: -50mV) which made the subject the titanium oxide which created the rutile ore as a starting material. As a result, the generating efficiency of the oxygen gas at the time of supplying pure water reached even to 16vol%. Then, vacuum suction was suspended, the valve was made close and heating was continued. As a result, when the pressure and temperature in a reaction vessel rose gradually and passed for 20 minutes, it became about 1.5 atmospheres and about 600 \*\*, and the recombination reaction of the emitted oxygen gas and hydrogen gas occurred, and the inside of a reaction vessel fell at a stretch to 0.8 atmosphere.

[0029](Example 6 of an experiment) Except that standard oxidation reduction potential used a +50 mV (there are many rates of  $\text{TiO}_2$ ) catalyst, it experimented on the same conditions as said example 1 of an experiment. As a result, the generating efficiency of the oxygen gas at the time of supplying pure water became 8vol%. Then, vacuum suction was suspended, the valve was made close and heating was continued. As a result, when the pressure and temperature in a reaction vessel rose gradually and passed for 50 minutes, it became about 1.5 atmospheres and about 600 \*\*, but the recombination reaction did not occur.

[0030]The above explanation shows an example of operation of this invention, and this invention is not limited by the illustrated example. For example, although the example of a graphic display

showed the device of every width, the fixed type which may be a vertical mold and a reaction vessel does not rotate may be used. About a catalyst, they may be not only a granular material but a honeycomb structured body, and slit shape. It is possible a water supplying means and not only a metallic pipe but for it to be considered as the structure which sprays water in the shape of a shower as the shape of a hollow disc, or to make it provide in a reaction vessel by using an electrode as a different body, and to also connect an electrode to an RF generator.

[0031]

[Effect of the Invention]As explained above, according to this invention, as compared with the conventional method, the decomposition temperature of water is low, and equipment can also be miniaturized. Since a raw material is also only water (pure water), discharge of the carbon dioxide leading to global warming can be made into theory top zero.

[0032]Since it can decompose even if it makes reaction temperature low to about 300 \*\*, the hydrogen manufacture by the waste heat management of the turbine of a thermal power plant or a nuclear power plant or the waste heat management of the incinerator on the refuse incineration of cities, towns and villages is also possible. For this reason, the reduce manufacturing cost of large hydrogen can be planned.

[0033]Therefore, when hydrogen gas was not a large-scale place of business, it was not able to be manufactured until now, but the manufacture possibility in a small-scale place of business can arise, and it can \*\* also to the spread of hydrogen fueled cars with a small environmental impact compared with the car which will use gasoline and gas oil as fuel in the future.

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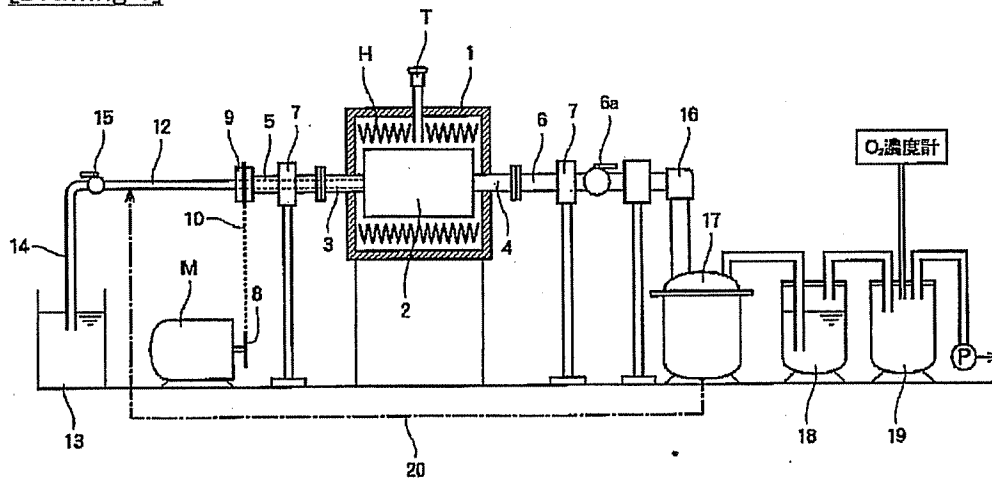
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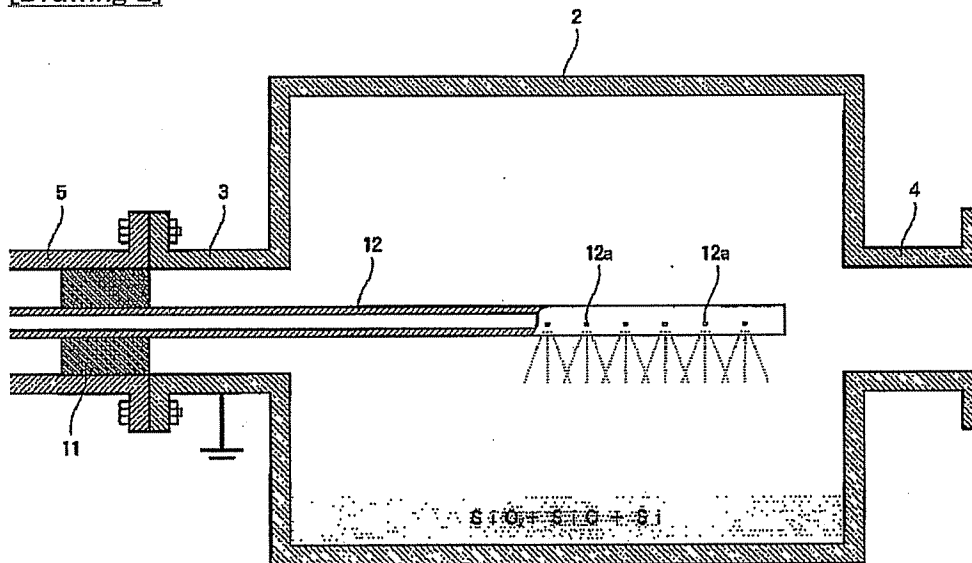
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DRAWINGS

[Drawing 1]



[Drawing 2]



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